EPA
United States
Environmental Protection
Agency

Duration and Frequency in Numeric Nutrient Criteria

Goal: Review the importance of duration and frequency components in numeric nutrient criteria, and how to use existing scientific information to derive them

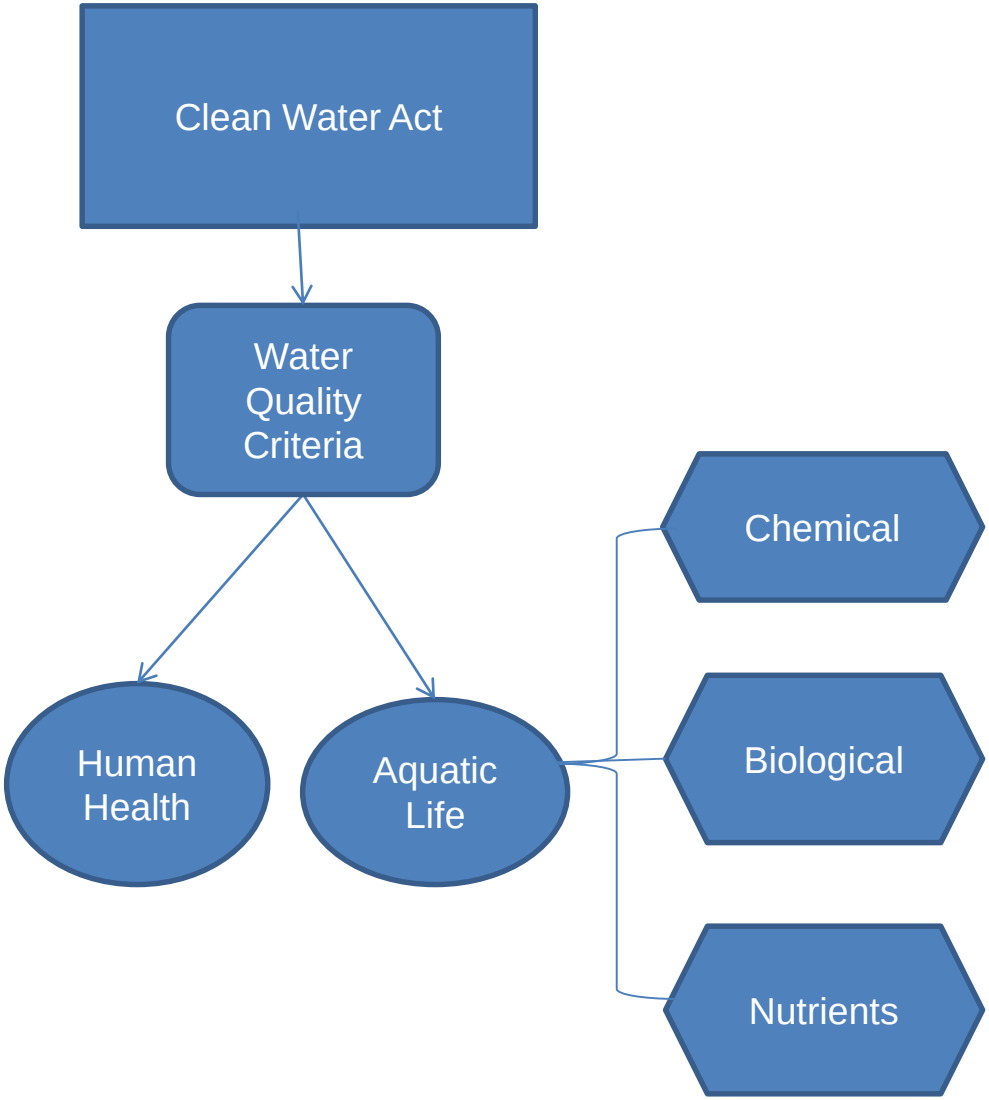
Outline

- Background
- Water quality criteria for aquatic life protection
- Establishing protective duration and frequency
- Nutrient criteria
  - Waterbody specific considerations for duration and frequency

Nutrients and Water Quality Management

Section 304(a)(1) of the Clean Water Act (CWA) requires criteria for water quality.

- Reflects the latest scientific knowledge on:
  - Extent of effects on human health and welfare
  - Concentration and dispersal of pollutants
  - Effects of pollutants on ecosystem dynamics



Water Quality Criteria for Aquatic Life Protection

- When adopting water quality criteria into standards subject to EPA review and approval under CWA section 303(c), states and tribes should describe the following criteria components:
  - Magnitude
  - Duration
  - Frequency
- Adopting all three components into standards meets EPA requirements in the CWA and at 40 CFR 131.11 (a)(1).

Water Quality Criteria for Aquatic Life Protection

Three components:

1. Magnitude (concentration): How much?
2. Duration: How long?
3. Frequency: How often?

Water Quality Criteria for Aquatic Life Protection

Water quality criteria composed of a criteria magnitude, duration, and frequency:

- Provide a means to balance the complex, and sometimes rapidly changing, dynamic nature of nutrient pollution with implementation of the criteria in programs such as permitting, assessment, and total maximum daily loads
- Provide states/tribes with flexibility to adapt numeric criteria to reflect unique characteristics of different types of waterbodies

Establishing Duration and Frequency of Numeric Criteria

Consider the following when determining duration and frequency:

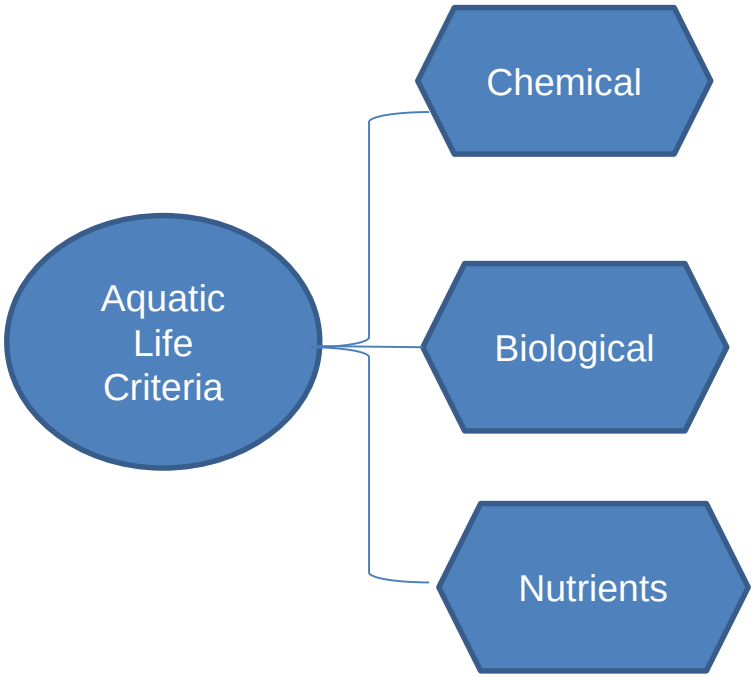
- Ability of ecosystems to recover
- Physical and biological features of the ecosystem
- Life cycle of sensitive species
- Effects of a substantial pollutant fluctuation and continuous exposure

Establishing Duration and Frequency of Numeric Criteria

- In general, EPA recommends one exceedance over a three-year period to protect aquatic life against long-term effects of pollutants.
  - This recommendation is a product of EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (1985).
- Documented studies of ecosystem recovery are few.
  - Most are based on toxic (chemical) pollutants.
  - Available science indicates most aquatic ecosystems are likely to recover from most exceedances in three years.
  - Some systems recover from small stresses in six weeks whereas other systems take more than 10 years to recover from severe stress.

Establishing Duration and Frequency for Nutrient Criteria

- Short-term exposure may not be easily noticed
  - Waterbody specific
  - Often masked by other pollutants
  - Differ among sensitive species
- Long-term exposure may be irreversible
  - Loss of ecosystem value and aquatic life
  - Regime change in lakes
- Current research on the effects of nutrients on ecosystem health and aquatic life provide a good basis for establishing a criteria magnitude



Making Progress on Duration and Frequency

- Understand and characterize nutrient dynamics.
  - Seasonality of nutrient concentrations, delivery of loads (e.g., spring floods)
  - Seasonality of effects (e.g., summer growing seasons)
  - Ensure there is data to characterize these dynamics (e.g., statistics)
- Match compliance monitoring with analyses used to support criteria development.
  - EPA's guidance recommends using the same or a similar method of data gathering for compliance purposes as used in the analysis to derive the criteria (EPA 2001, Technical Guidance: Lakes and Reservoirs, p. 7-17)

Key Concepts

- To identify protective criteria and standards, nutrient criteria should:
  - Be developed exclusively on scientifically defensible methods
  - Be based on ecological changes as well as statistically significant differences in compiled data

Waterbody-Specific Considerations: Rivers and Streams

- Rivers and streams have a shorter residence time than lakes and reservoirs.
- Rivers and streams have a high probability of scour, removing algae from location of origin and transporting nutrients downstream.
  - Nutrient concentration is likely more applicable than load in these systems because of flow.
- Evaluate nutrient conditions at low and stable flow to determine the criteria duration.
  - The effects of eutrophication might be most pronounced at low flow.
  - This is a critical period for accumulation of algal biomass.
- Evaluate the frequency and timing of floods and scouring to understand the local response to nutrients in extreme conditions.

Waterbody-Specific Considerations: Lakes and Reservoirs

- Residence time is waterbody-specific.
- Researchers caution against the application of steady-state assumptions; the effects of spikes in nutrient loading could linger and disrupt the steady state.
- Phytoplankton may respond faster than periphyton.
- Duration may differ for a drinking water designated use and a recreational designated use.
- It is important to understand the role of a given lake/reservoir in nutrient management.

Waterbody-Specific Considerations: Estuarine and Coastal

- Locally the response is not always evident, which creates a challenge in deriving site-specific duration and frequency components.
- Data from a broader spatial scale may help determine the duration and frequency of nutrient pollution.
- Residence time and mixing are key.

Lessons Learned

- Numeric nutrient criteria not only establish a magnitude for the protection of aquatic life, but also a frequency and duration to ensure their stability.
- Additional studies are needed to better understand how long it takes different waterbody types to recover from long periods of elevated nutrient concentrations.
  - Response to ecosystem perturbation
  - Increased research on ecosystem dynamics
  - Documented scientific information of ecosystem health and aquatic life expectations
  - Detailed assessment frameworks at the state level